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WILLIAM H. MEADOWCROFT.

Mr. Wm. H. Meadowcroft, who recently severed his connection with the General Electric Co., has connected himself with the Parrot Storage Co., of New York City. Mr. Meadowcroft came to the United States from Manchester, England, in 1875. He had been employed in his native city in a law office and soon after arriving in New York entered the law firm of Carter and Eaton. He remained in this office five years and was admitted to the New York bar in 1881. Mr. Eaton, of the law firm, having accepted the vice presidency of the Edison Electric Light Co., Mr. Meadowcroft left the legal profession and took up the study of physics and practical electricity in the same company. He remained with the Edison Electric Light Company 18 years. In 1885 he started the incandescent lamp department of the General Electric Co. On the announcement of Roentgen's discovery Mr. Meadowcroft immediately began experimentations upon the same lines and for the purpose of making the results of his labors essentially useful for the physician and diagnostician. After going through the long course of experiments he finally brought out a line of x-ray tubes that have been pronounced the best obtainable for all round work. Prof. Elihu Thomson also patented the double focus tube in 1896, which Mr. Meadowcroft manufactured in large quantities. He also decided upon the type of exciting apparatus for x-ray work manufactured by the Electric Light Co., and had full charge of sales of all x-ray apparatus. The manufacture of the fluoroscope was also under his charge from the time they were first made. His practical work of making radiographs of all forms of accidents and injuries for the past three and a half years for hospitals, physicians and friends has reached the highest grade of excellence. The A. B. C. of the x-rays written by him in less than eight months after Roentgen's discovery sold all over the world and is still held as a standard primer on the subject of the x-rays.

Mr. Meadowcroft, on leaving the General Electric Co., was given a farewell banquet by his friends and associates of the Miniature Lamp Department at Harrison, New Jersey. He made a very graceful speech, in which he expressed his regrets at parting with them. In his new department he will probably be engaged much of his time in the manufacture of automobiles.

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VOL. 5. *ST. LOUIS, NOVEMBER, 1899.* *NO. 5.*

THE WEHNELT INTERRUPTER IN X-RAY WORK.

BY PROF. BENJ. F. BAILEY.
LABORATORY OF ELECTRO-THERAPEUTICS, ANN ARBOR, MICHIGAN.

To the possessor of a good induction coil, any method of increasing its efficiency for x-ray work is of value. The Wehnelt interrupter is particularly useful, as it does away with the costly and troublesome primary or storage battery, the mechanical interrupter, and the condenser, at the same time it greatly increases the capacity of the coil. It can be very cheaply made, and will operate on any commercial lighting circuit, either alternating or direct. A disadvantage is that the interrupter is not very durable, but a few minutes work will make a new one, so this is not a serious defect.

The essential parts of the interrupter are a glass jar of one part of sulphuric acid to four or five of water, a large sheet of lead to act as cathode, and the anode. This usually consists of a piece of platinum wire about No. 18 in size, with from one-eighth to one-quarter inch exposed to the liquid. It must be connected with the outside by means of an insulated conductor. The greatest difficulty is with this insulating covering as it is difficult to find a substance that will not be attacked. For the jar a good-sized tumbler will do, and a sheet of lead about four by three inches for the cathode. One method of making the anode is to seal a piece of No. 18 platinum wire about one-half inch long in the end of a short piece of glass tubing of about one-quarter or one-eighth inch bore, leaving about one-eighth inch projecting. The tube is then supported in any convenient way so that the platinum point is below the surface of the liquid. Innumerable modifications of this arrangement can be made. The cathode may be made entirely to surround the anode, or the end of the glass tube may be bent so that the platinum anode points toward the cathode. The platinum is apt to crack out of the glass, and it is claimed that if the wire is sealed in the bottom of a small beaker so as to get a larger quantity of mercury near the wire, this is not so apt to occur. The liquid heats up quite rapidly as about 200 to 400 watts of energy is consumed there, and to prevent it getting too hot, several devices may be used. One method is to make the cathode of a coil of small lead pipe, and pass cold water from the faucet continually through this pipe. This, of course, causes a slight grounding which might make some trouble if the supply circuit were badly grounded. Another method of construction is to solder end to end a short piece of platinum wire and

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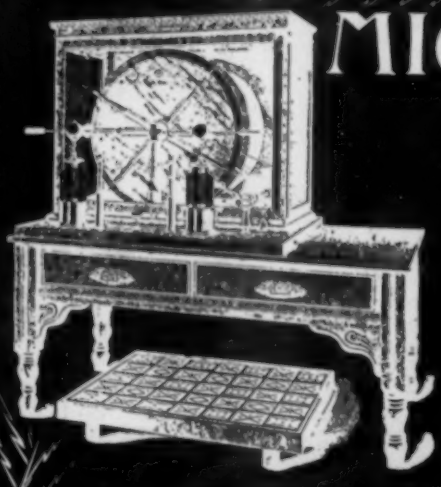

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a piece of copper wire of the same diameter, so that the combined wire is of the same diameter at the joint as at other places. The whole is then passed through a three inch piece of fibre tube, the bore of which it fits closely. The end of the tube is then heated and moulded around the wire, or some other method adopted to make a close joint. If the electrolyte can penetrate the joint, it will cause decomposition of the tube, but a tight sliding fit even will prevent this for a long time. The base of a burned-out incandescent lamp, if the platinum points are sufficiently far away from the metal base, makes an excellent interrupter for currents not exceeding about three amperes, and any number of them can be readily obtained.

The frequency depends somewhat upon the length of the platinum point and an adjustable interrupter is of course desirable. Such an instrument made in Germany was experimented with, but did not give entire satisfaction, as the liquid penetrated at the sliding joint and attacked the rubber fittings. The frequency is however easily regulated by varying the self-induction in circuit, leaving the point of the right size to carry the current desired, so there is no great need of such an adjustment when the interrupter is regularly used with the same coil.

The other accessories required outside of the coil are an inductive and a non-inductive resistance. The former may best be a water resistance. It consists of a glass jar of about a gallon capacity. A metal or carbon plate on the bottom is connected by an insulated conductor with the outside and another plate of the same substance is arranged so it can be immersed more or less in the water. The resistance can be lessened by increasing the immersion of this plate or by adding salt to the water. Any other variable non-inductive resistance can be used. Incandescent lamps would do very well and have the advantage of furnishing an approximate idea of the amount of current passing.

For an inductive resistance 200 turns of No. 18 wire wound on a bundle of iron wires 8 inches long and 3 inches in diameter will do very well. Taps should be brought out after 10, 25, 50 and 100 turns so that the number of turns in circuit can be easily varied.

Any good coil will work with the interrupter. If made especially for this use the primary will be wound with finer wire so it will require less current. The vibrator and condenser will of course be omitted. A ten inch spark coil wound for use with the storage cells in series will take about ten amperes. If wound for use with the interrupter two or three amperes will suffice.

To use the apparatus provision must first be made for a sufficient current supply. A lamp tap if provided with heavier conductors than the ordinary cords would furnish five amperes, but for ten amperes it would probably require heavier fuses. The non-inductive resistance, interrupter, coil, inductive resistance and a switch, preferably of the double pole variety, should be connected in series. An ammeter in the circuit is desirable but not essential. If an ordinary coil is used the vibrator should be screwed up so that it cannot act. This also short circuits the condenser. The discharge rods of the coil should be close together and the movable plate of the water rheostat at its highest point when the current is turned on. Gradually decrease the amount of resistance. If everything is all right, when the current reaches about five amperes the interrupter will begin to act. A bright light somewhat resembling the electric arc will appear around the platinum point, and a loud crackling sound will be heard. The discharge should also appear be-

tween the terminals of the coil. If instead of this the interrupter refuses to act and the platinum point turns a dull red, the connections are probably wrong and the terminals of the interrupter should be reversed.

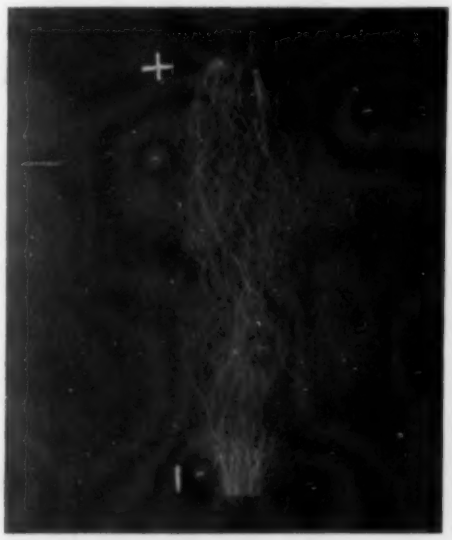

FIG. 1.

The appearance of the discharge is shown by Fig 1. The interruptions are so frequent that the output of the coil is greatly increased, and the character of the discharge is entirely changed. The photograph shows a distinct polar effect. The spark is thickened near the – end, and is there sharp and clear cut, while the + end is much blurred. A photograph of the ordinary induction coil discharge shows merely a wavy uniform line with no polar effect whatever. The frequency of interruption can be increased by decreasing the number of turns of self-induction in circuit. If cut down too much, however, the interrupter will refuse to act.

An ordinary single focus tube is the best to use. It is connected as usual to the two terminals of the coil, and the appearance and action of the tube are practically the same as with the ordinary interrupter, but the quantity of x-rays produced is much greater. If long exposures are to be made it is advisable to have two interrupters with a switch, so connected that if one gets too hot or refuses to act, the current can be switched through the other.

In one respect the Wehnelt interrupter is absolutely unique in that it can be used with the alternating current to give a unidirectional discharge at the secondary of the induction coil. It can be used in this way even more simply than with the direct current, and with equally good results. The connections are the same except that the inductive resistance is not needed. With 50 volts E. M. F. a coil and interrupter can be used without any external resistance, but on 100 or more volts a non-inductive resistance becomes necessary. The appearance of the secondary discharge is the same as with the direct current, and the terminals exhibit distinct polarity. A single focus tube should be used, and the connections are the same as before.

The reason for this marked polarity is I believe as follows: With 125 complete cycles per second the current falls from its full value to zero in $\frac{1}{125 \times 4} = \frac{1}{500}$ seconds. This with five amperes of current in an ordinary coil causes an E. M. F. capable of bridging an air gap of about one inch. With the interrupter in circuit the spark will jump six inches. The difference is due to the greater rapidity by which the interrupter breaks the current. Assuming that the E. M. F. is proportional to the spark length which is very nearly true for lengths above one inch, the time consumed in breaking would be about $\frac{1}{100 \times 6} = \frac{1}{3000}$ seconds. The breaks take place only when the current is passing from the platinum point to the lead plate. This accounts for the polar effects, as the E. M. F. generated by the regular alternation of the

current is not sufficient to bridge the air gap or pass through the tube. If, however, the discharge rods be gradually approached to within about one inch the usual discharge will be succeeded by an alternating high tension arc, the E. M. F. generated being then sufficient in both directions to force the current across the gap.

FIG. 2.

The radiograph of the fish was taken with the alternating current and a single focus tube. It certainly shows as good definition as can be obtained with direct current excitation.

No operator of an induction coil who has access to a commercial circuit, either alternating or direct, of any voltage not exceeding 250 should fail to try this method. The cost of the apparatus is small, and the results obtained will be well worth the trouble.

Sept. 25, 1899.

Restoring Impaired Screens.

Mr. W. S. Andrews, of Schenectady, N. Y., has kindly offered to restore impaired screens that are unvarnished. Fluoroscopes and open screens, after long use, careless handling or when exposed to artificial heat, become dull and brown. Sometimes screens lose their former degree of fluorescence and do not much change in color. All such screens Mr. Andrews will gladly receive for treatment. It will pay those in possession of such screens to correspond with Mr. Andrews.

Re-Enforcing Screens.

A. Lounde has determined, after a series of experiments, that the sulphide screens have an indisputable re-enforcing action. Screens made of platino-cyanid of barium, platino-cyanid of potassium and tunstate of calcium, have no particular action in this respect. While the sulphid of calcium and the sulphid of zinc do have re-enforcing action. Lound uses the sulphid screen for the detection of missiles in deep cavities or remote from the surface, allowing time for the re-enforcing action, which is about two minutes.

A Student of the University of Vermont is said to have instituted suit in the sum of $10,000 against one of the professors in that institution for injuries received from an exposure of a fractured leg to the x-ray, for the purpose of taking a photography of the injured member. The writ declares that, as a result of the exposure, discoloration of the flesh occurred, with subsequent atrophy of the tissues. All told, ten skiagraphs had been taken.—*Exc.*

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A DOUBLE-FOCUS X-RAY TUBE FOR THE ACCURATE LOCALIZATIONS BY FLUOROSCOPE OR PHOTOGRAPHIC PLATE OF FOREIGN BODIES.

BY CHARLES LESTER LEONARD, A. M., M. D.
Skiagrapher to the University Hospital; Instructor in Clinical Surgery in the University of Penn.; Demonstrator of Roentgen-Ray Diagnosis in the Philadelphia Polyclinic Laboratories.

The detection and localization of foreign bodies in the tissues and various hollow viscera was one of the most obvious of the useful applications of the Roentgen-ray method of diagnosis.

This method can not be criticised for the failures that resulted from the inaccuracies of its early employment. The mathematical accuracy which has been obtained by various methods based upon geometrical principles is absolute. A method based on a series of triangulations was published by the author early in 1897. The technic required for its accurate application seems to have been a barrier to its general employment.

To simplify the application of the same principles the author has had constructed a tube having two cathodes and two anodes, and hence two sources of rectilinear rays. While avoiding the errors that creep in, where the position of the tube has to be changed in relation to the part examined and the plate or plates, it has also made rapid, accurate localizations by means of the fluoroscope easy. Localizations can be made with it without the delays necessitated by the development and fixation of the negative.

The fluoroscopic method of localization is as follows: The screen is fixed in a perpendicular position. The tube is placed so that the rays are discharged towards the screen in a horizontal plane. The mid point of the line connecting the two sources of light is perpendicular to the plane of the screen, at a known distance from a point on its surface marked by an opaque cross. This is all the adjustment that is required and can be readily made with a square.

The limb containing the foreign body is then interposed between the tube and screen and the shadows of the foreign body made to fall, one on either side of the opaque spot and equally distant from it on the same line. This places the foreign body on the line perpendicular to the plane of the screen at the opaque point. The opaque spot is then marked on the patient's skin with nitrate of silver.

By placing an opaque rod on the other side of the limb where its two shadows are equidistant from the opaque spot the perpendicular is found and marked on that side. The foreign body therefore lies on this line at a distance from the opaque spot that is determined by measuring the distance between the two shadows of the foreign body with calipers, and plotting the shadowy paths by the graphic process, as when plates are employed or by the cross-thread method devised by MacKenzie Davidson.

A rapid method of determining the result is to construct a table similar to the following, which will be approximately correct for each observation where the tube is at a certain fixed distance from the fluorescent screen.

When the mid-point between the foci is at a perpendicular distance of twelve inches from the screen and the foci are five inches apart, the distance from the opaque spot to the foreign body will be for—

1-4 inch apart, 5-8 inch.
1-2 inch apart, 1 1-4 inch.
3-4 inch apart, 1 3-4 inch.
1 inch apart, 2 1-4 inch.
1 1-4 inch apart, 2 5-8 inch.
1 1-2 inch apart, 3 inch.
1 3-4 inch apart, 3 3-8 inch.
2 inch apart, 3 5-8 inch.

The accompanying illustration shows the tube to have double cathodes and an-

odes. Two sources of rectilinear rays are thus placed at a known fixed distance

Fig. 1. Diagram illustrating method of employing localizing tube and determining results by the graphic method.

apart in the same tube. They therefore produce two shadows of the foreign body upon the fluorescent screen as has just been discribed or upon the photographic plate, if that method of localization is preferred.

No other apparatus is required in making localizations and the errors that arise in shifting the tube or changing plates are avoided. Thus accurate localizations are produced by those who have little x-ray technic.

The method of employing it and of obtaining the result by the graphic method can be better understood by referring to the diagram.

The tube with its anodes AA^1 is placed at a measured distance, B E, above the photographic plate PP^1. The point on the plate, perpendicular beneath the midpoint E of the line conecting the two foci, is found by a plumb-line or square, and is marked by a lead wire cross, attached by a wafer to the plate wrapper at B. The shadow of this cross is the point from which the measurements are made on the plate.

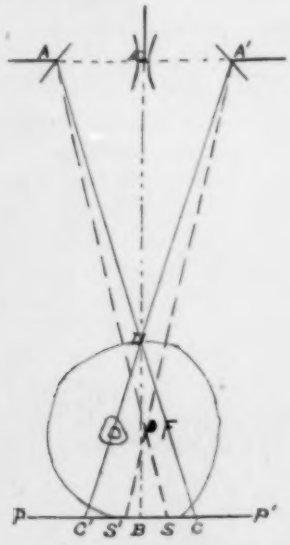

Fig. 1. Diagram illustrating method of employing localizing tube and determining results by the graphic method.

A mark is made on the patient's skin approximately in the transverse plane of the limb in which the foreign body lies. This spot is placed in contact with the lead-wire cross at B. A further point for measurements can be determined by placing a second lead-wire and nitrate of silver mark on the opposite side of the limb in the line E B at the point D by means of the plumb-line.

An exposure is then made. The developed plate shows the fixed point B and the shadows SS^1 of the foreign body F, while CC^1 are the shadows of the second localizing point. Our previous measurements and the distances of these shadows from the point B which can

be readily measured, enable us to construct a diagram similar to the illustration for every case and to draw the lines AC and A^1C^1, AS and A^1S^1 which locate by their intersections the points D and the foreign body F. When such a geometrical figure is drawn from definite measurement the distance of F from B and D the nitrate of silver points on the patient's skin can be readily measured, which, with its distance from the line D B locates it with the accuracy necessary for surgical operation and removal.

The following mathematical formula will give the same results. In the triangles F A A′ and F S S^1 let E B = H, F B = X, S S′ = b and A A′ = a—then

$$\frac{x}{H-X} = \frac{b}{a}; \quad \frac{x}{H} = \frac{b}{a+b}; \text{ or } x = H\,\frac{b}{a+b}$$

The result can also be obtained by the cross-thread localizer, or from a table constructed as in the fluoroscopic use of this tube mentioned above.

Clinical experience has demonstrated the accuracy of this localizing tube. A young lady had the point of a steel pin imbedded in her wrist. The x-rays had been used but inaccurately. The localization showed it to be 3-16 of an inch below the surface. A careful dissection at the point indicated disclosed it imbedded in a flexor tendon, with the point protruding inwardly and causing serious functional disturbance.

Several bullets had been located by it and the measurements found by operation to be correct.

1930 Chestnut St., Philadelphia.

There are 225 publications entered at the St. Louis post office as second class matter. Of this number one-ninth are medical journals. The American X-Ray Journal figures heavily in the gross weight. The total weight of all publications entered as second class matter for the quarter ending Sept. 30th amounted to 4,624,786 pounds. This is the lightest quarter of the year.

Neural Dynamics.

This is the title of a paper read by Dr. W. J. Herdman, of Ann Arbor, Mich., before the American Med. Ass. at Denver, 1898. Additional, the Doctor says: "Certain of these ether waves, those with a rapidity of vibration from 293,000,000,000,000 to 757,000,000,000,000 per second 'not only produce thermal and chemic effects, but have the power when they strike the retina of the eye of causing changes in the layer of rods and cones, which in their turn act as a stimulus to the optic nerve. The primary stimulus is here, as in the touch, muscular, auditory and temperature sense end-organs, a wave of motion communicated from an external source either by direct contact or through the medium of the air or the ether. If the rods and cones be wanting, as when the structure of the retina atrophies, ether waves, within the specified range for the normal retina, may beat upon the wasted surface continuously, but without avail in exciting light sensations. The peculiar structural or molecular arrangement which is present in the normally acting rods and cones of the retina is indispensable for the production of visual sensations, as likewise are ether waves of the proper rapidity.

While we do not know positively the nature of the change which takes place in any one of the forms of sensory end-organ so far considered, when acted upon by its appropriate kind of motion, analogies in physics and mechanics teach us that the end-organ is simply a machine devised for transforming that special form of motion into another form of motion that we term nerve-motion. The majority of the facts, which we have not now time to enumerate, appear to justify the conclusion that the first step in this transforming process is a chemic change, a re-arrangement in

the protoplasmic molecules of which the cells in the end-organs are made up."

It is interesting to read some of these facts that have long since been conceded. The x-rays have complete vibration per second 288,224,000,000,000,000, which is a complete period beyond the ether rays that impinge upon the retina. Denial has been made that the x-rays in any way affect the cones and rods. But Prof. Roentgen observed visual effects from the x-rays when no fluorescent matter was before the eyes. Many other persons have observed the same. Dr. Astudillo, of Havana, Cuba, treated blind persons with the x-rays for the purpose of restoring sight. Of the twenty cases he treated, phenomena were observed in all. One case completely recovered, and others regained some sight. The structure of the retina had, in several cases, atrophied to the extent that light (expressed in 8½ octaves) no longer stimulated the rods and cones, and they therefore wasted. When the x-rays were used, they were sufficient to give impressions of light—and this stimulus to the retina brought on repair. The effect of the lesser light being inadequate to longer afford stimulus to the retina and secondarily to the optic nerve, the greater light, the x-ray has been found in some cases to supply the deficiency, and through its effect to restore the sight. This is analogous to starvation brought on by food not sufficiently rich in the essentials of life, but when supplied physical normalcy is restored.

Visibility of Roentgen Rays.

Mr. Dorn, whose experiments with the effect of Roentgen rays on eyes have been noticed before, describes some further researches in the *Wied. Ann. 66,* p. 1171, with totally color blind persons in which he found that such eyes may be very sensitive to Roentgen rays. In the case described in an abstract of the paper in Science Abstracts, February, the rays appeared of a nearly blinding intensity to the subject while they were only faintly luminous to the ordinary eyes. The results showed that the rods are more sensitive than the cones.

Lung and Heart Reflexes.

Abrams' paper is given to the description of two reflexes, apparently hitherto undescribed, on the part of the lungs and heart. A pulmonary neurosis of dilation can be produced by irritation of the nasal mucosa, e. g., firmly pressing cotton into both nasal cavities. He thinks this has a value in diagnosis as aiding in discovering regions of imperfect pulmonary expansion which exist. The heart reflex is due to irritation of the skin in the precordial region. It is only manifest by the Roentgen rays. The lung reflex can also be produced by cutaneous irritation, and he thinks this affords a therapeutic suggestion as showing the value of cutaneous stimuli, in bronchopneumonia for example, while he considers that the effectiveness of the Schott treatment in cardiac weakness is practically largely due to this action.

Physical and Fluoroscopic Examination of of the Thorax.

Dr. Stubbert concludes, after an exhaustive study of the diseases of the chest, that: 1. The fluoroscope is an accurate agent for corroborating and extending diagnoses made by ordinary methods. 2. It is capable of demonstrating foci of tubercular infection earlier than they can be distinguished by the ear. 3. It shows unilateral or bilateral enlargement or displacement of the heart. 4. Emphysema, asthma, pleurisy, hydro-pneumothorax and pneumonia are all easily recognized, and their limits demonstrated. 5. Thoracic aneurisms are recognizable in their early stages.

The Electrolytic Interruptor in X-Ray Work.

BY JOHN HALL-EDWARDS, L. R. C. P., F R. P. S.

Since the publication of my article upon the above subject in the British Journal of Photography I have continued to make experiments, the result of which I feel will interest those of your readers engaged in x-ray work.

The passage of the electric supply current through the interruptor is regulated by the following conditions:

1. The relative sizes of the electrodes.
2. Their distance apart.
3. The specific gravity of the fluid.
4. The length of platinum wire exposed.

In order to obtain any interruptions at all, it is absolutely certain that the lead plate must present a surface many times the area of the platinum wire. That there is no necessity, however, for the large surface of lead used in most interruptors, I have proved by experiment. With platinum wire (20 B.W.G.) half an inch in length, I tried lead plates offering a surface of from one to thirty-two square inches, and the ammeter (an exceedingly delicate instrument) failed to show any appreciable difference in the amount of current passed.

In order to test the effect of distance between the electrodes, I constructed an interruptor in a glass tank over two feet in length. With a solution of sulphuric acid and water of a specific gravity of over 1015 only a very slight difference in the amount of current passing was noticed, no matter how small or great the distance between the electrodes. With a solution of very low specific gravity (1005) much more current passed when only half an inch apart than when the distance was increased to four inches; between four inches and two feet, however, no appreciable difference could be measured.

So much depends upon the specific gravity of the electrolyte, that too much attention can not be given to this point. The amount of resistance offered by the interruptor can, by varying the specific gravity of the fluid, be regulated to the greatest nicety, and to such an extent as to render the use of a rheostat unnecessary. The experiments upon which these conclusions are founded were carried through with the assistance of Mr. J. C. Vaudry, the managing director of the Birmingham Electric Supply Company who kindly placed at my disposal a voltmeter and ammeter of exquisite sensitiveness.

The experiments were made with a nominal 110 volt circuit, which at the time was supplying a regular flow of 119 volts. The arrangement of the apparatus during the experiments will be understood by reference to the diagram (Fig. 3). The voltage of the current passing through the primary of the coil was measured by the drop which was registered across the interruptor.

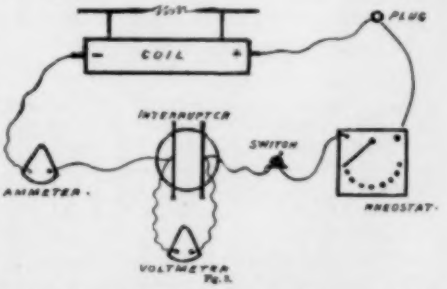

Fig. 3.

The vessel containing the interruptor was large, and contained 200 ounces of solution. The platinum wire was 20 B.P.W.G., and half an inch was exposed. The lead plate was 16 square inches and the distance between the electrodes was 3 1-2 inches.

In the measurements here recorded the rheostat was entirely cut out of circuit, the full 119 volts being passed through the interruptor.

With plain water, specific gravity

1000, the ammeter failed to give any reading, so that less than a quarter of an ampere passed. The voltage across the interruptor showed a drop to 115, thus 4 volts passed through the coil,* which gave a spark of only half an inch in length. The platinum wire in the interruptor gave off but a few bubbles and did not become red hot. Half an ounce of pure sulphuric acid was now added (specific gravity 1002), 3 amperes at 5 volts now passed a good supply of sparks 3 or 4 inches in length, passing between the sparkers. Sulphuric acid was now added, half an ounce at a time, until the specific gravity reached 1023, when 8.5 amperes at 13 volts was used. The spark now assumed the violet-blue color mentioned in my last article, and twisted about between the sparkers, which were placed about 8 inches apart.

A complete record of the experiments will be seen by a glance at Fig. 4.

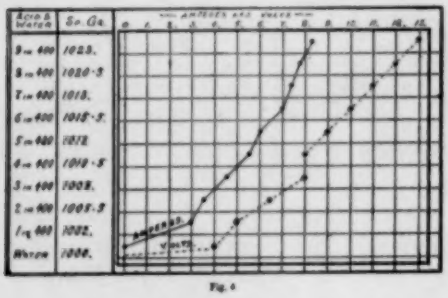

Fig. 4

These experiments prove that, with a platinum electrode of fair size, the interruptor can be completely controlled by varying the specific gravity of the solution, and, moreover, that the quantity of acid generally recommended is far in excess of that really necessary. A five per cent solution , which, with the acid I used, gave a specific gravity of 1048, required, with the same arrangement, an additional resistance of about 5 ohms before it could be used with safety. Under these circumstances, however, matters can be speedily rectified by cutting off a piece of the platinum wire.

From these experiments I concluded that a 220 volt current would be used, which conclusion was subsequently verified.

The length and size of the platinum wire used in the anode constitutes one of the most important points in the construction of the interruptor, as has to an extent been already shown. I have been called to task by a contemporary for recommending a wire so small as 20 B.W. G. This has, in my hands, proved so successful that I continue to use it. I have never had the apparatus stop working since I adopted it, and I rarely get a broken tube. In most of the bought interruptors a larger size is used, but experience alone can teach which is the better.

An interruptor in which the length of

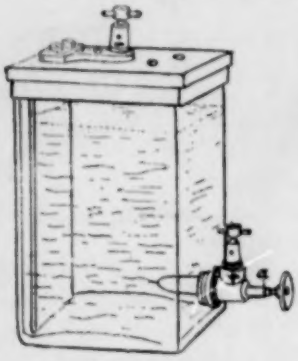

Fig. 5.

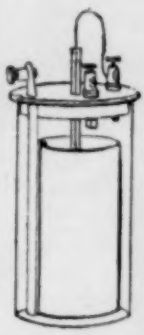

Fig. 6.

the platinum wire exposed can be regulated at will is a great advantage, as, by taking note of what has been said of the influence of the specific gravity of the electrolyte, any size coil can be worked from any current up to 220 volts without a rheostat. An adjustable interruptor is shown in Fig. 5. In this instrument the platinum wire passes through a small hole in a piece of china, or baked clay, the length being varied by the screw, A.

Fig. 6 shows a form of interruptor in

*The coil, with platinum contact-breaker and 12-volt accumulator, gives a full 12-inch spark.

which the anode is surrounded by a cylinder of lead.

It must be kept in mind that a considerable amount of gas is generated when an interruptor is at work, and, moreover, that it is given off in the proportions necessary for forming water; hence under no circumstances should a light be brought near the vessel after it has been working for any length of time, or a serious explosion may occur. It is also very desirable that, in covered interruptors, large holes should be provided for the free escape of the gases, or an explosion may occur from internal pressure.

The behavior of Crookes tubes when worked with the interruptor is a matter of much interest. Small tubes are next too useless, as they heat very rapidly, and in many cases the vacuum is so much reduced after a few seconds' working that no x-rays are produced. They are not necessarily spoiled, as with the platinum contact-breaker the vacuum can soon be raised to the desired point again. I have purposely thus reduced the vacuum of several tubes I had put away as useless with a marked measure of success.

The tubes I have worked most successfully with the interruptor are large ones with a bulb of at least six inches in diameter. A medium high vacuum gives the best results, and it is an advantage to somewhat raise the vacuum of a new tube by means of the contact-breaker before using it with the interruptor. A tube in which there is a tendency for the vacuum to increase even when the anti-cathode is raised to a red heat is the ideal one for working with the interruptor, and is likely, with care, to last for a considerable time. In some tubes, owing, no doubt, to the presence of some metal in the solder which is easily volatilised, the vacuum is reduced to such an extent as to render them next to useless immediately the current is switched on; such tubes are perfectly useless for our purpose.

In several tubes in which the anti-cathode is composed of a fairly thick piece of metal, with a thin covering only of platinum, a hole has been melted through the latter metal before any indication of its reaching the melting point was observed. As long, however, as the thicker metal support was not melted, I have noticed no great falling off in their working power. No tube in my hands will run for longer than a minute when sufficient current is passed through to enable it to give a maximum amount of x-rays. The anti-cathode must be carefully watched, and the current switched off directly it assumes a full red heat. Fifteen to thirty seconds rest must be given before the current is again passed through. The having to switch on and off the current is a nuisance, which can only be avoided by a considerable alteration in the methods of manufacturing tubes.

I have noticed some curious phenomena in the working of tubes with the interrupter for which I can give no explanation. With the contact-breaker, or mercury interrupter when a tube reached so high a vacuum the sparks refused to pass through, they either jumped or brushed over the outside of the tube. When the same thing occurs with the electrolytic interrupter, the spark evidently passes through, as is seen by a small glow near the cathode end, or a bright spot somewhere on the surface of the glass, but no x-rays are produced, although no sparks are to be noticed on the outside of the tube. If, however, the tube be left working, it will suddenly be lighted up, and will continue to work until it has again rested, when the same process will have to be repeated.

When passing a large amount of current through a tube of high vacuum, a

fine brush of sparks sometimes covers the whole surface of the glass. Several times when doing this I have noticed that a patch of glass about three-quarters of an inch in diameter exactly opposite the anti-cathode pole, and immediately beneath the cathode, has ceased to fluoresce, and in the brightly lighted tube appears as a black patch. From the centre of this a bright, fairly thick spark passes to the cathode terminal. On first seeing this I naturally thought that the tube was ruined, so put in resistance and allowed it to go on working. Much to my surprise, the tube worked steadily on, so I again repeated the experiment. The spark in question appeared to come through the glass; at the same time the vacuum of the tube was not reduced. The experiment appears to be fraught with danger, but I mention it in the hope of getting some explanation of the phenomenon.

In using the fluorescent screen with the interrupter I have failed to notice any marked increase in the fluorescence, although its steadiness is a great advantage. In taking radiographs, however, not only does the necessary exposure appear to be lessened by the rapidity of the interruptions, but the power of the x-rays appears to be increased. If this is so, I take it that the reason why the screen does not show more is due to the fact that under both conditions the maximum amount of fluorescence is produced, and, in order to obtain better results in this direction, we must have improved screens.

The introduction of the electrolytic interrupter opens up new fields for research, and, apart from its application to x-ray work, it is likely to prove of great service to mankind.—*The British Journal of Photography.*

Subscription to the AMERICAN X-RAY JOURNAL is invariably in advance. The blue pencil cross-mark indicates delinquency. The small price of one dollar for this journal should not stagger any one.

Luminosity or Rare Earths Produced by Cathode Rays.

A Royal Society paper by Mr. Swinton is reprinted in the *Lond. Elec. Rev.*, June 2. He describes experiments made with a number of the rare earths when heated in vacuum and by cathode rays, in endeavoring to explain certain actions of these oxides. He found that thoria and ceria both alone and mixed, behave quite differently when heated by cathode rays than when heated by a Bunsen flame. Incidentally it may be mentioned that a rough estimate of the amount of light showed that there were at least 150 candles per square inch of incandescent surface at an expenditure of approximately one watt per candle. The conditions of maximum luminosity, however, were exceedingly unstable.—Swinton.—*Lond. Elec. Rev.*, June 2.

The Pineal Gland and Sexual Development.

Dr. Heubner, of Berlin, had the following interesting case: A boy, 4½ years old, presented the development of a boy of eight or nine years, as well as an abnormally large penis, well-developed scrotum and testis, the pubes being covered with hair. The boy suffered in infancy from spasms of the larynx, his speech developing slowly. Up to 7½ months the development was normal, the abnormal growth having taken place within one year after that period. He finally developed hydrocephalus, and, by means of the x-rays, a tumor was located in the neighborhood of the hypophysis cerebri. The boy died, and an autopsy revealed a tumor of the pineal gland.—*International Medical Magazine.*

Seeing with "Dark Light."

We have already described the experiments of Gustave Le Bon on what he calls "dark" or "black" light (lumiere noire), which consists, according to his account, of certain rays that remain after all the visible rays have been filtered out from ordinary light by an opaque screen, and which has some of the properties of x-rays. His first experiments, made several years ago, did not produce conviction in the minds of the majority of scientific men; many who tried to repeat them were unable to do so, and those who succeeded believed that the results could be explained differently. But M. Le Bon has continued his investigations, and some of his recent results, as described by him before the Paris Academy of Science, are made known in an article contributed to La Nature (March 25) by M. A. de Marsy, that we translate below. Says this writer, speaking of M. Le Bon's so-called "dark light":

"This invisible light, which is capable of acting on a photographic plate, includes many different kinds of radiation, which M. Le Bon did not have time to dissociate at the moment when he published his investigations. So his experiments, when repeated by others, were followed by contradictory results, and were variously interpreted by writers on physics.

"The author has continued his investigations, and in recent notes published in the Transactions of the Academy of Sciences, he has separated from the mass of heterogeneous and confused radiation called by him 'dark light,' a few clear elementary forms.

"In the first place he has studied invisible residual light, and has shown that dark bodies can be photographed in darkness by means of the totally invisible light that they store up after a short exposure to sunlight. He has proved experimentally that this light is refracted, is polarized, has a spectrum like that of ordinary light, and preserves its photographic properties more than a year.

"This point established, he has studied the transparency of opaque bodies for different luminous radiations. That the eye may see through an opaque screen we must evidently have two conditions fulfilled: first, some rays must pass through this screen, and, second, the eye must be made sensitive to these rays.

"By certain artifices, which he described elsewhere, the author has succeeded in making the photographic plate sensitive to the obscure radiations. Having then obtained photographs through opaque bodies, he naturally concluded that some luminous rays passed through the latter.

"But the exposures at that time lasted several hours and it was necessary to operate by contact. The results thus might be interpreted in all sorts of ways.

"Pursuing his researches, the author finally found a reagent whose sensitiveness is five thousand times greater for invisible rays than that of the photographic plate. Having obtained his result, he has been able to show in a few seconds the transparency of the most opaque bodies, and to render visible an object placed behind a screen or shut up in a box, taking as source of light a simple kerosene lamp entirely enclosed in black paper. The sensitive reagent is the phosphorescent zinc sulfid prepared by the method of Charles Henry. It is laid upon a translucent or opaque screen by mixing it with varnish.

"Such a screen has very curious properties. Exposed to the light of day it phosphoresces; but if certain rays be separated from the visible light by passing it through proper screens, the invisible rays thus filtered out extinguish the phosphorescence instantly, and do so

proportionately to the thickness or the nature of the interposed screens. Now these extinguishing rays (whose wave-length M. Le Bon has determined by a method that we shall not explain here) are the ones that can pass through opaque bodies.

"The image obtained by interposing the screen between the source of light and the opaque body lasts only a few instants, and is visible only in the dark. To make it lasting and transform it into an ordinary photographic impression, we have only to place the screen for thirty to forty seconds against a gelatin-bromid plate, which is then developed by the usual methods.

"The times necessary to obtain an image through various substances are as follows: ebonite, 1 centimeter (0.4 inch) thick, ten seconds; four sheets of black paper, ten seconds; marble, 2 centimeters (0.8 inch) thick, five to thirty seconds; board, ½ centimeter (0.2 inch) thick, sixty seconds; twelve sheets of red paper, seventy seconds, etc.

"Of all the bodies investigated, only lampblack (except metals, which the author reserves for another series of experiments) appeared to be opaque. Bodies containing it, such as certain kinds of black paper and ebonite, were opaque for this reason. Making use of this opacity of lampblack, the author was able to photograph a design in printer's ink placed in an envelope of black paper deposited in an ebonite box. This photograph was among those that he exhibited at the Institute.

"As most of the rays that pass through opaque bodies are invisible ones, it follows that we can screen off the visible rays of the source of light, and that this may be, as mentioned above, a kerosene lamp surrounded with black paper. In absolute darkness the observer then sees on the screen (sensitized previously by a short exposure to daylight and placed against an opaque box) the object shut up in this box. The best results are given by boxes whose ends have been replaced by black paper, or better still, by ebonite. ....

"One of the published photographs shows that the spectrum of the radiations that pass through opaque bodies is much more extensive than that of the radiations that do not so pass. It reaches from (wave-length) 0.7 to more than 1.5, according to the author's measurements. Since the visible rays of the spectrum destroy the action of the invisible rays, the author concludes that to study the physiologic action of these latter on plants and animals, we must separate the two kinds of radiations. We shall probably have occasion to speak of the experiments that he is now making on this point."—Translation made for *The Literary Digest*.

Bullet Retained in the Heart.

BY DR. A. G. FORBES.

A sixteen-year-old girl shot herself accidentally in the heart with a pistol, and two hours later was admitted into the clinic. Heart action almost stopped. Wound at junction of sternum and fifth rib on the left side. The wound was enlarged and drained, but as improvement was only temporary, an operation was undertaken. On opening the pericardium, a longitudinal wound was discovered in the right ventricle. Needle punctures to locate the bullet were unsuccessful. Then the heart was palpated carefully between the two hands, but no bullet could be found. As the wound was already scarred over, no sutures were made. Eight weeks after the operation the wound had entirely closed. Three months later the patient was reported well. An x-ray taken three months after operation plainly showed the bullet in the lower half of the right ventricle, with which it moved synchronously.—Exc.